STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

Report of Reflective Marker Installation Made on the Ridge Route in December, 1956

State of California
Department of Public Works
Division of Highways
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MATERIALS AND RESEARCH DEPARTMENT
3435 Serra Way
Sacramento, California

FEB 25 1957

Contract 57-7VC8
VII-L.A-4-G
W.O. 57-7VV49

Mr. E. T. Telford
Assistant State Highway Engineer
Division of Highways
Los Angeles, California

Dear Sir:

Submitted for your consideration is:

Report

of

Reflective Marker Installation

Made on the Ridge Route

in

December, 1956

Study made by . . . . . Technical Section
Under General Direction of . . . . . Bailey Tremper
Work Supervised by . . . . . D. L. Spellman
Report prepared by . . . . . D. L. Spellman

Yours very truly

F. N. Hveem

F. N. Hveem
Materials and Research Engineer

cc:E. Withycombe
M. Harris

REFLECTIVE MARKER INSTALLATION MADE ON THE RIDGE ROUTE

As a result of an agreement with District VII, the Materials and Research Department installed reflective markers on portions of the median on Contract 57-7VC8, under Work Order 57-7VV49.

The section selected for test consisted of a 4-lane highway with a six foot wide median separating opposing traffic. The pavement and median was part of a resurfacing contract still in progress at the time the markers were being installed. The test section is about one mile in length, the remaining portions of the median are planned to have raised traffic bars at approximately 40-foot intervals.

The purpose of the investigation is to study alternates to raised bars with respect to their tendency to collect debris and the ease of removal of collected debris. Comparisons of day and night visibility can also be made.

Description and Location

On December 18, 19 and 20, 1956, a total of 953 reflective units was placed in three different patterns. Two types of units were used; "ovals" and "wedges". Details of these units and arrangements are shown in Figure 1. A total of 531 "ovals" was used to make 59 rows of 9-oval "bars", and

422 wedges were used to make 99 "bars" in two patterns.

The 9-oval bar stands out quite well and gives an appearance similar to a solid raised bar. The wedge patterns appear to be "open" and do not appear to be bars even with the close spacing. The location of each group is as follows:

Pattern No. 1 - 20 rows 4 wedges to a row, rows 40' cc	Sta. G215+71 to G223+60
Pattern No. 1 - 66 rows 4 wedges to a row, rows 20' cc	Sta. G270+23 to G283+28
Pattern No. 2 - 13 rows 6 wedges to a row, rows 30' cc	Sta. G246+65 to G250+55
Pattern No. 3 - 59 rows 9 ovals to a row, rows 40' cc	Sta. G223+60 to G246+65

Installation Procedure

The location of each unit was marked on the pavement with the aid of keel and a template constructed for that purpose. The adhesive was then applied to the pavement and the unit immediately pressed into place working it back and forth until contact was made with the pavement. Excess adhesive was scraped up with a putty knife. In spreading the adhesive a metal shield was used having a hole the same size and shape as the unit being placed and was 1/8-inch thick. A wide spatula was used to spread the layer in one stroke. After the adhesive had hardened the units were etched with full

strength hydrochloric acid. The acid was brushed on, allowed to "work" for about a minute and was then scrubbed off with a brush and clear water. This operation removes the thin cement coating on the glass beads and brings out their reflective quality. About 88 man hours were required to complete the field work.

This represents time spent on the work only. A four-man crew was used. One man mixed the adhesive using a small Hobart mixer powered by a motor-generator set; the remaining three were engaged in spreading adhesive, setting the markers and cleaning up. The time spent per unit was 0.092 man-hour.

The adhesive used was the epoxy-resin type compounded in the following proportions:

Shell Epon	1000 grams
Thiokol LP-3	400 grams
DMP-3 Catalyst	100 grams
Filler - Marter White Silica	as needed

The materials were packaged in friction top cans at the laboratory. The Epon was placed in a quart can. The thiokol and catalyst, after mixing, were placed in a pint can. The contents of the two cans together with the filler were mixed at the site of the work. The batch, about 1-1/2 quarts in size, is the largest quantity that can be used since the mixture begins to harden after 8 minutes. The filler serves to control the viscosity and the amount used was about 1-1/2 lbs. per batch. The amount to be used was determined by trial and depended

mostly on prevailing temperature conditions. More filler could be used in warm weather than in cool weather. The air temperature at the time this installation was made, varied from about 55 to 60°F in the mornings to 65°F in the afternoons. While temperatures generally above 50°F for several hours are needed to harden the adhesive, cold weather work can be carried on by the use of metal heaters. The heaters can be made of channel or other suitable shapes. They are first heated with a gas flame and then placed over the units to be "cured." They form an oven and are effective in raising the temperature sufficiently to cure the adhesive in about 20 minutes. Heat cannot be applied directly to the units as this causes them to crack.

After establishing the correct amount of filler to be used, the procedure was to add the epon and filler to the mixer and thoroughly mix them before adding the thiokol and catalyst. This procedure helps insure a homogeneous mixture. Mixer parts and tools coming in contact with the adhesive must be cleaned immediately before it sets and it will be difficult, if not impossible, to remove it. For this purpose an aromatic solvent such as Socal No. 1 is convenient.

Adhesive Cost

The 1-1/2-quart batch of adhesive, applied at a nominal thickness of 1/8-inch was sufficient to cement 28 wedges or 45 ovals.

While the cost of some materials is less when purchased in large quantities, the approximate cost of materials for one batch is as follows:

Epon	1000 grams at $0.83 per lb.	$1.83
Thiokol	400 grams at $0.96 per lb.	.85
DMP-30	100 grams at $1.00 per lb.	.22
Filler	1-1/2 lbs. at 4¢ per lb.	.06
	Cost of material per batch	$2.96

The cost of the adhesive was 10-1/2 cents per wedge and 6-1/2 cents per oval.

Manufacture and Cost of Reflective Units

The reflective markers were fabricated in the laboratory, cured and packed in boxes of 20 each. The proportions and approximate cost of each material is listed below:

Glass beads	31 lbs. at 14¢ per lb.	$4.34
White cement	15 lbs. at 3.9¢ " "	.55
Titanium Dioxide	4 lbs. at 26¢ per lb.	1.04
	Material cost for one batch	$5.93

Each batch makes approximately 100 of either the "wedges" or the "ovals." Water is added to the dry ingredients to produce a workable mix and it is then placed in molds. The next day the units are stripped from the molds and placed in water for curing of not less than 7 days. The cost of materials in the markers is about 6¢ each.

Estimates of cost per unit may be made from the following data:

	Wedge	Oval
Materials only per unit	$0.06	$0.06
Materials only in adhesive	0.105	0.065
Labor, (field mixing, applying adhesive, setting units and clean-up) per unit, man-hour	0.092	0.092
Labor, (manufacturing and packing units) man-hour per unit	0.04	0.04

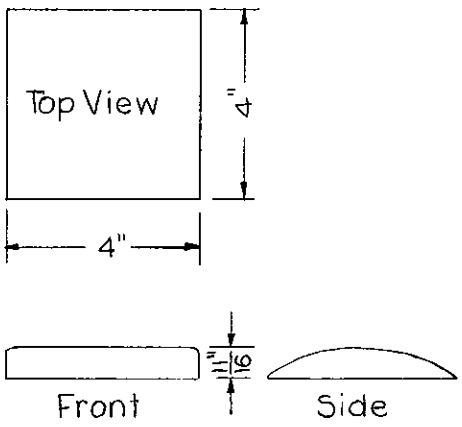
On this project the film thickness of adhesive as it was applied was necessarily high because of the surface texture of the pavement. Some excess of adhesive was needed because of failure to finish the bottoms of the units to a true plane. Under more favorable conditions the thickness of adhesive could be reduced substantially but it would then be necessary to reduce the size of the batch of adhesive mixed at one time because of the limited pot life.

While this installation was made on bituminous pavement, these units have been successfully applied to portland cement concrete pavements. The procedure would be the same.

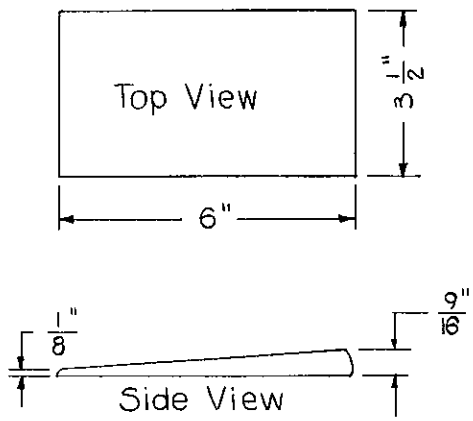
Figure 1

REFLECTIVE MARKER DETAILS

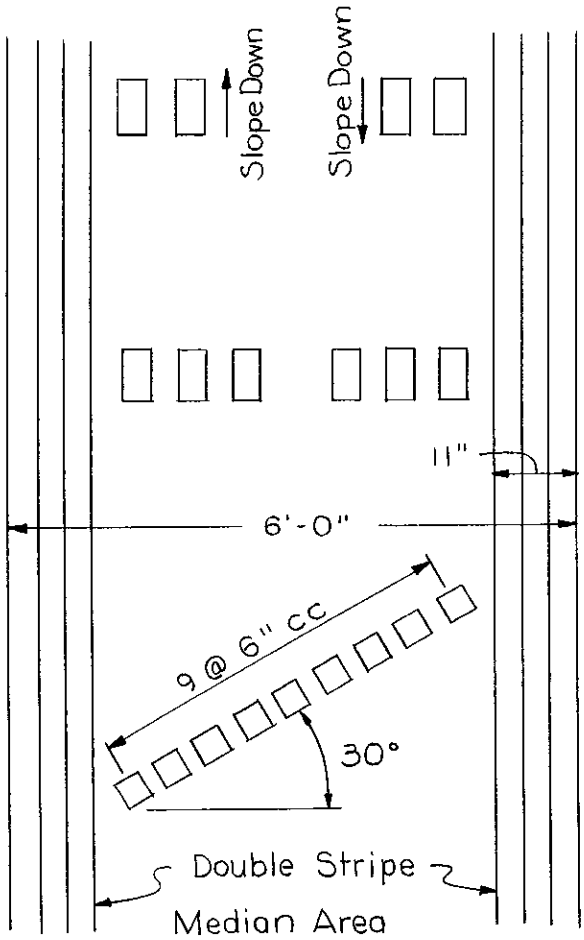
57-7VC-8



OVAL



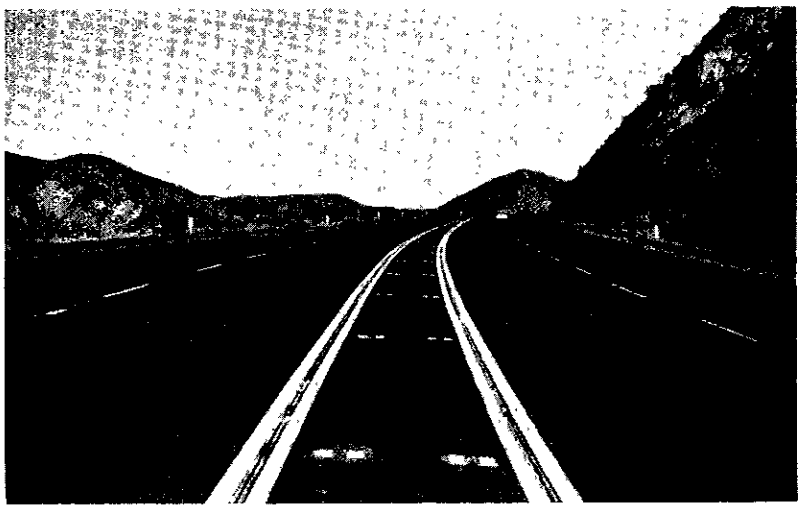
WEDGE



Pattern No. 1 (Wedges)
66 rows 20' cc
20 rows 40' cc

Pattern No. 2
13 rows 30' cc

Pattern No. 3
59 rows 40' cc

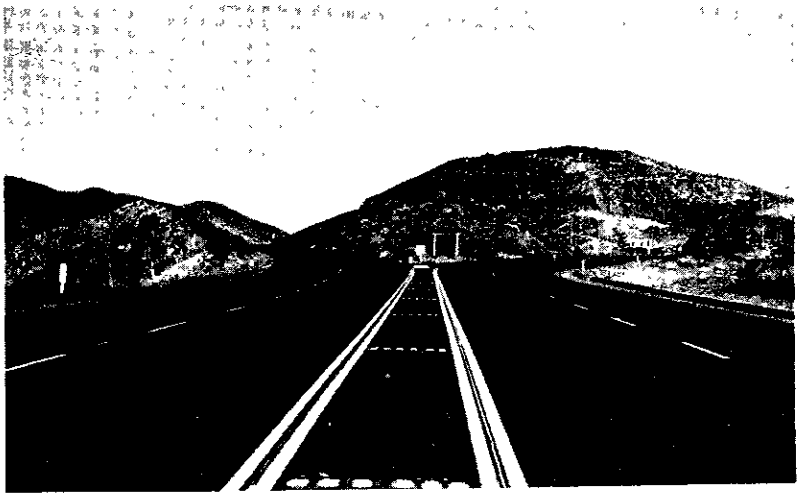


Pattern No. 1

20 Rows

4 wedges to a row

Rows shown are 20' c.c.

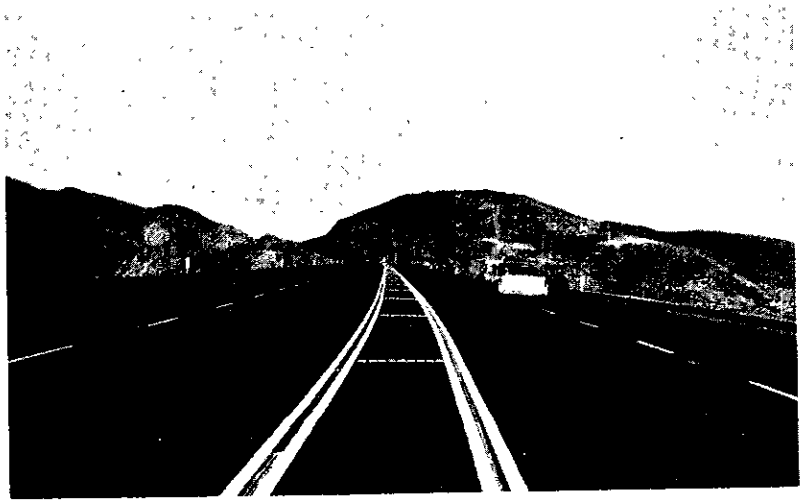


Pattern No. 2

13 rows

6 wedges to a row

Rows shown are 30' c.c.



Pattern No. 3

59 rows

9 ovals to a row

Rows shown are 40' c.c.

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